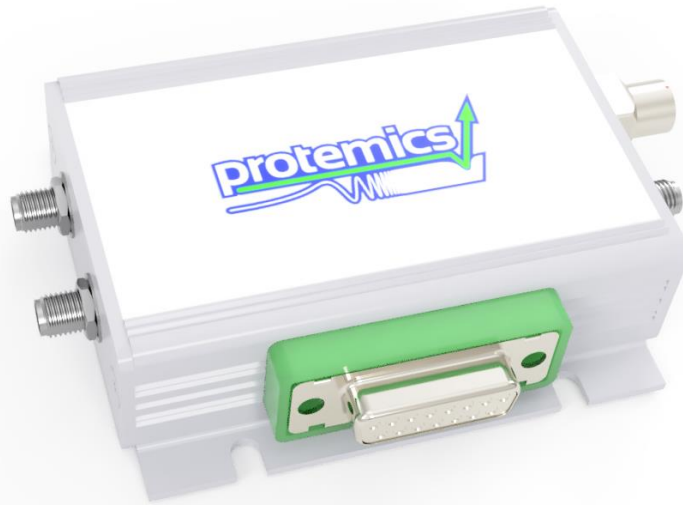# TECHNICAL DESCRIPTION

TeraSpike **Companion**

Advanced Low Noise Current Amplifier for THz Sensors

THE new TeraSpike Companion is the first commercially available low-noise amplifier specially designed and optimized for THz time-domain spectroscopy applications based on photoconductive detectors and emitters - including of course the full line of Protemics TeraSpike (TS) microprobes. In contrast to conventional current amplifiers, the TS Companion offers important additional functions that are typically required for THz-TDS-related tasks, including e.g. Connections for Tx and Rx devices, an optical alignment mode, a switchable bias function for all inputs as well as a fully electronic control for system integration. A fine selection of amplification in steps of a fifth of a decade is included for optimal utilization of the maximum possible signal-to-noise ratio in any THz system. As required for operation with fast-scanning THz TDS modules (e.g. TeraFlash Pro, Toptica), it also offers a comfortable bandwidth reserve that ensures unadulterated THz signal detection up to the highest amplification range.

Key Features

- Two input channels for Tx and Rx connection
- Operation mode switchable between optical alignment & THz detection
- Trans-impedance (gain) variable in 0.2×10^x steps from 1×10^6 to 8×10^8 V/A
- Bandwidth DC/400 Hz to 40 kHz
- Dynamic bias voltage
- Local and remote control options
- Wide operating supply range

Applications

- Protemics near-field probe operation including transceiver, emitter, or detector probes
- General Terahertz photoconductive antenna operation
- Photodiode and photomultiplier amplifier
- Multichannel current acquisition system
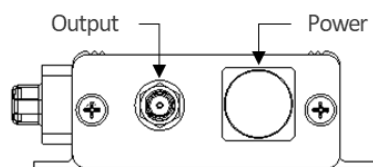- Preamplifier for lock-ins, A/D converters, etc.
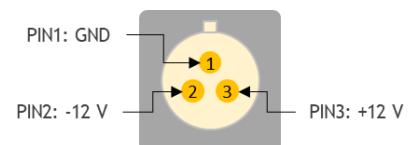
Block Diagram
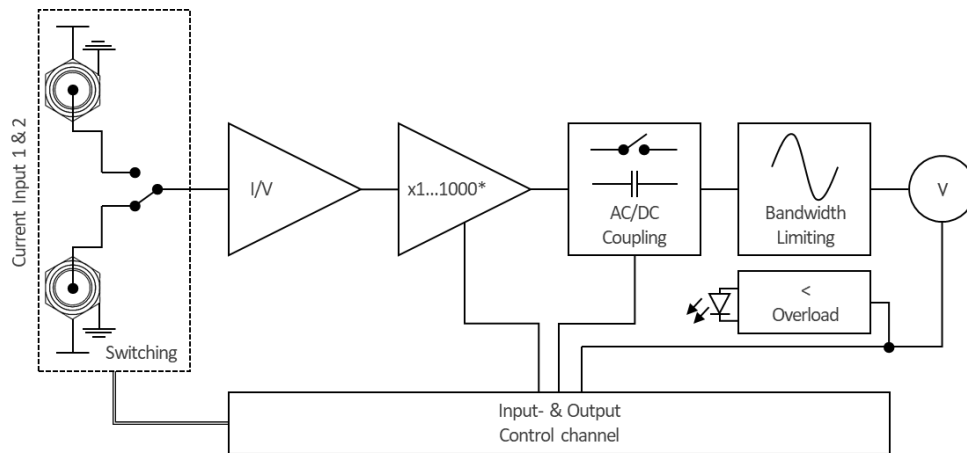
Interface description
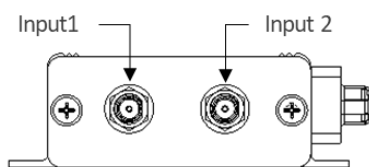
Input side view

Input1: SMA, isolated, jack female
Input2: SMA, isolated, jack female
Detector bias output: shield of the
input1 SMA & input2 SMA

Output side view

Output: SMA, jack female

Power supply connector

PIN1: GND
PIN2: -12 V
PIN3: +12 V

Socket: Lemo series 0B, 3-pin fixed
socket
Plug: Matching parts
FGG. 0B.303.CLAD52
Pin 1: GND Pin 2: -12 V Pin 3: +12 V

Specifications

Model	LNA-40k-8E8
Trans-impedance gain [V/A]†	$1 \times 10^6 \dots 8 \times 10^8$, switchable in steps of 0.2×10^x
-3-dB-Bandwidth [kHz]†	40, for all gain settings. Switchable to 0.4
Amplifier output voltage [V]	±12
Output impedance	Open
Max. output current [mA]	±40
External bias supply for THz device inputs	±12 V, max. 120 mA
Indicator LED	On: Overload, Off: Normal operation
Power supply voltage	±5 V… ±14 V (max.), ±12 V (recommended)
Power supply current	Typ. ±50 mA

Weight [g]	120
Operating temperature range	0… 70°C

Test conditions: Vs = ±12 V, T_A ≈ Room Temperature, Load Impedance = 10 MΩ

†*Can be customized on request. For further information please contact us at info@protemics.com*

Digital Control

Control bus connector
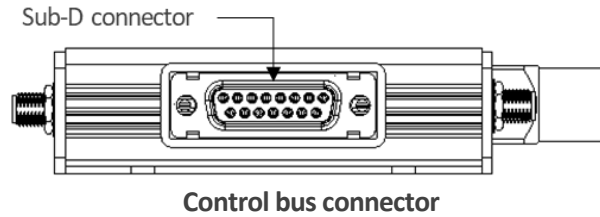
Model	LNA-40k-8E8
Control input voltage range LOW bit	-12 V… 0.8 V, recommended: GND/0 V
Control input voltage range HIGH bit	2.4 V… +12 V, recommended: 5 V
Control input current range	± 1 µA @ 0.8 V (LOW) … 2.4 V (HIGH)

Pin	Description
Pin 1	Signal output (connected to SMA)
Pin 2	Supply +12 V
Pin 3	Digital control input: AC/DC
Pin 4	Digital control input: Gain
Pin 5	Digital control input: Gain
Pin 6	Digital control input: Controls Input1
Pin 7	NC
Pin 8	Digital control input: Controls Input2
Pin 9	GND
Pin 10	NC
Pin 11	Digital control input: Gain
Pin 12	Digital control input: Gain
Pin 13	Channel for supplying voltage to Input1
Pin 14	Digital control input: Input1/Input2
Pin 15	Channel for supplying voltage to Input2

Remote Control Mode

In remote mode the device is controlled using a Sub-D 15-pin interface:

Pin	Function	Mode [Input/Output] Address [LOW/HIGH]: Function
Pin 1	Signal output (connected to SMA)	Output
Pin 2	Supply +12 V	Output
Pin 3	Digital control input: AC/DC	Input: HIGH: AC … LOW: DC
Pin 4	Digital control input: Gain	see gain selection
Pin 5	Digital control input: Gain	see gain selection
Pin 6	Digital control input: Controls Input1	Input: LOW: GND … HIGH: Voltage
Pin 7	NC	-
Pin 8	Digital control input: Controls Input2	Input: LOW: GND … HIGH: Voltage
Pin 9	GND	Input
Pin 10	NC	-
Pin 11	Digital control input: Gain	see gain selection
Pin 12	Digital control input: Gain	see gain selection
Pin 13	Channel for supplying voltage to Input1	Input
Pin 14	Digital control input: Input1/Input2	Input: HIGH: Input … LOW: Input2
Pin 15	Channel for supplying voltage to Input2	Input

Manual Control Mode

In manual mode the device is controlled using the manual control plug:

Switch/ Terminal Block	Function	Address/Designation
Switch 1	Input1/Input2	HIGH/LOW
Switch 2	GND/Voltage, to input1	LOW/HIGH
Switch 3	GND/Voltage, to input2	LOW/HIGH
Switch 4	DC/AC	LOW/HIGH
Switch 5	NC	-
Switch 6	NC	-
Switch 7	A0 Gain	see gain selection
Switch 8	A1 Gain	see gain selection
Switch 9	A2 Gain	see gain selection
Switch 10	A3 Gain	see gain selection
Terminal Block	Stable supply +12 V	+12 V
Terminal Block	Ground	GND
Terminal Block	Stable supply +1 V	+1 V
Terminal Block	Ground	GND
Terminal Block	Signal output (connected to SMA)	Signal
Terminal Block	V2IN1, Channel for supplying voltage to Input1	V2IN1
Terminal Block	V2IN2, Channel for supplying voltage to Input2	V2IN2
Terminal Block	Ground	GND

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TeraSpike Companion

Gain Selection chart:

Gain	Pin/Address			
(V/A)	Pin 11/A1	Pin 4/A0	Pin 12/A3	Pin 5/A2
1×10^6	LOW	LOW	LOW	LOW
2×10^6	LOW	LOW	LOW	HIGH
4×10^6	LOW	LOW	HIGH	LOW
8×10^6	LOW	LOW	HIGH	HIGH
1×10^7	LOW	HIGH	LOW	LOW
2×10^7	LOW	HIGH	LOW	HIGH
4×10^7	LOW	HIGH	HIGH	LOW
8×10^7	LOW	HIGH	HIGH	HIGH
1×10^8	HIGH	LOW	LOW	LOW
2×10^8	HIGH	LOW	LOW	HIGH
4×10^8	HIGH	LOW	HIGH	LOW
8×10^8	HIGH	LOW	HIGH	HIGH

Typical Application Schematics

Some typical configuration examples for using the TeraSpike Companion in combination with TeraSpike microprobes are depicted in the following. Pin / Switch settings that need to be modified are marked in bold in the tables below.

Scheme 1: Probe Alignment
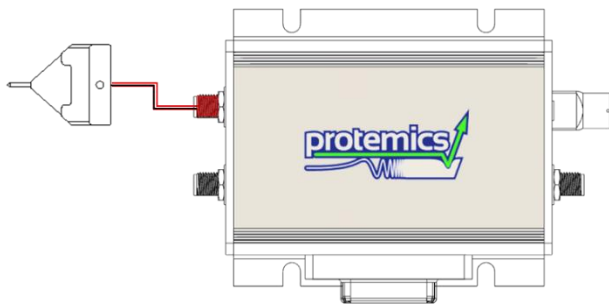
In this scheme, the probe is biased with an externally supplied voltage and the generated photo-current is amplified by the TeraSpike Companion. This scheme is typically used for the probe alignment of a probe-beam to the TeraSpike's photo-switch. The bias voltage is supplied to the probe by TeraSpike Companion's input connector outer shield (red channel for bias) via pin 13 (for input1) or 15 (for input2). For the TeraSpike Companion to operate in this scheme the following control address needs to be given at 15 pins Sub-D connector.

Control Address for TeraSpike Companion in remote control mode, where input1 is used for probe alignment

| Pin	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Control Address	*	*	**LOW**	Gain*	**HIGH**	-	**LOW**	GND	-	Gain*	Vbias	**HIGH**	*		

for more details please refer to, the remote control mode table

Switch status for TeraSpike Companion in manual control mode, where input1 is used for probe alignment

Switch/Terminal	1	2	3	4	5	6	7	8	9	10	Terminal	V2IN1
Switch Status	I	I	O	O	-		A0	A1	A2	A3		Supply +1 V externally*

for more details please refer to, the manual control mode table

Scheme 2: Terahertz measurement
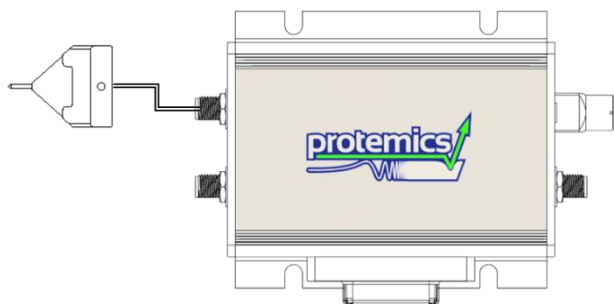
In this scheme, the TeraSpike microprobes are operating as THz antenna and the resulting current signals are amplified by the TeraSpike Companion. No bias voltage to the probe is required. For the TeraSpike Companion to operate in this scheme the following control address needs to be given at 15 pins Sub-D connector.

Control Address for TeraSpike Companion in remote control mode, where input1 is used for Terahertz signal

| Pin	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Control Address	*	*	HIGH	Gain*		LOW	-	LOW	GND	-	Gain*		*	HIGH	*
*for more details please refer to, the remote control mode table															

Switch status for TeraSpike Companion in manual control mode, where input1 is used for Terahertz signal

Switch/Terminal	1	2	3	4	5	6	7	8	9	10	Terminal	V2IN1
Switch Status	I	O	O	I		-	A0	A1	A2	A3		X
*for more details please refer to, the manual control mode table												

NOTE: If a user wants to use input2 of the TeraSpike Companion instead of input1, the necessary changes need to be done as given in the remote control mode table and manual control mode table depending on the mode of operation.

Scheme 3: Transceiver operation
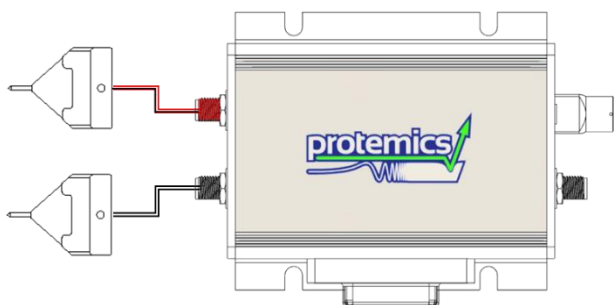
In this scheme, the input1 of TeraSpike Companion is biasing the probe for Terahertz generation, while the input2 is used for measuring the Terahertz signal. For the TeraSpike Companion to operate in this scheme the following control address needs to be given at 15 pins Sub-D connector.

TeraSpike Companion

Advanced Low Noise Current Amplifier for THz Sensors

Control Address for TeraSpike Companion in remote control mode,
where input1 is used for biasing the probe and input2 is for measuring the Terahertz signal

Pin	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Control Address	*	*	**HIGH**	Gain*	**HIGH**		-	**LOW**	GND	-		Gain*	Vbias	**LOW**	*
for more details please refer to, the remote control mode table															

Switch status for TeraSpike Companion in manual control mode,
where input1 is used for biasing the probe and input2 is for measuring the Terahertz signal

Switch/Terminal	1	2	3	4	5	6	7	8	9	10	Terminal	V2IN1
Switch Status	**O**	**I**	**O**	**I**		-	A0	A1	A2	A3		Supply +1 V externally*
for more details please refer to, the manual control mode table												

**Annotations: I: Logic HIGH, O: Logic LOW, X: Don't care**

NOTE: For Transceivers probe alignment, please refer to Scheme1 of TeraSpike Companion.

Have more questions about TeraSpike Companion configurations? please feel free to contact us at info@protemics.com
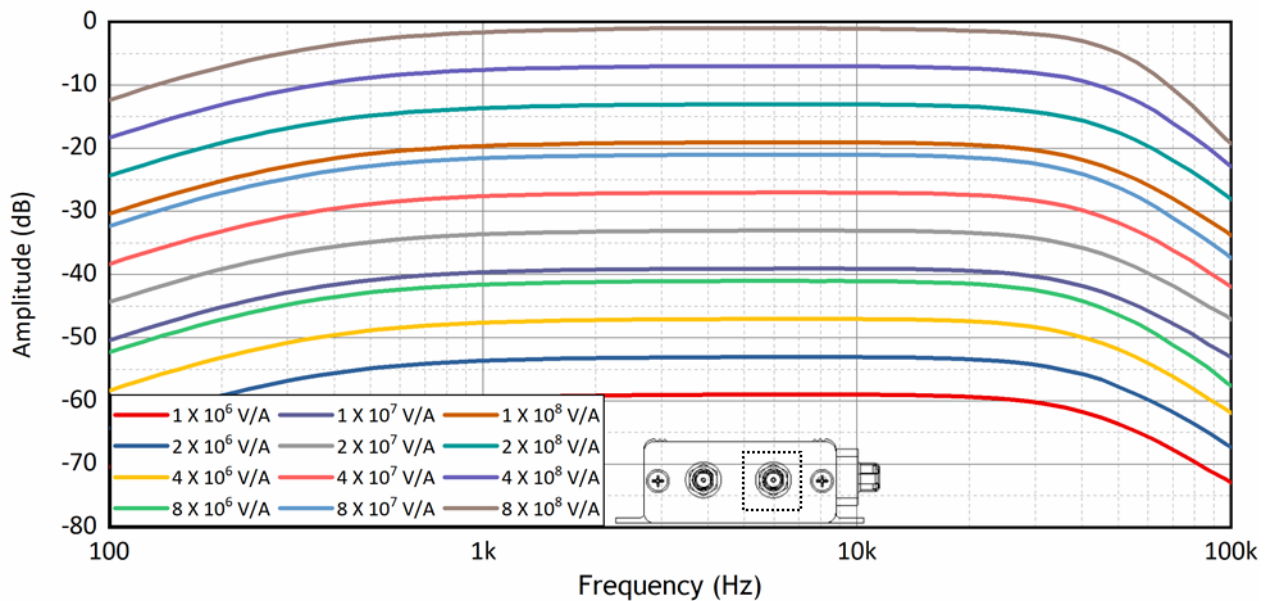
Typical Characteristics

At V_{s+} = +12 V, V_{s-} = -12 V, R_L = 10 MΩ, T_A ≈ Room Temperature.

The below graph shows the AC characteristics of input 1:
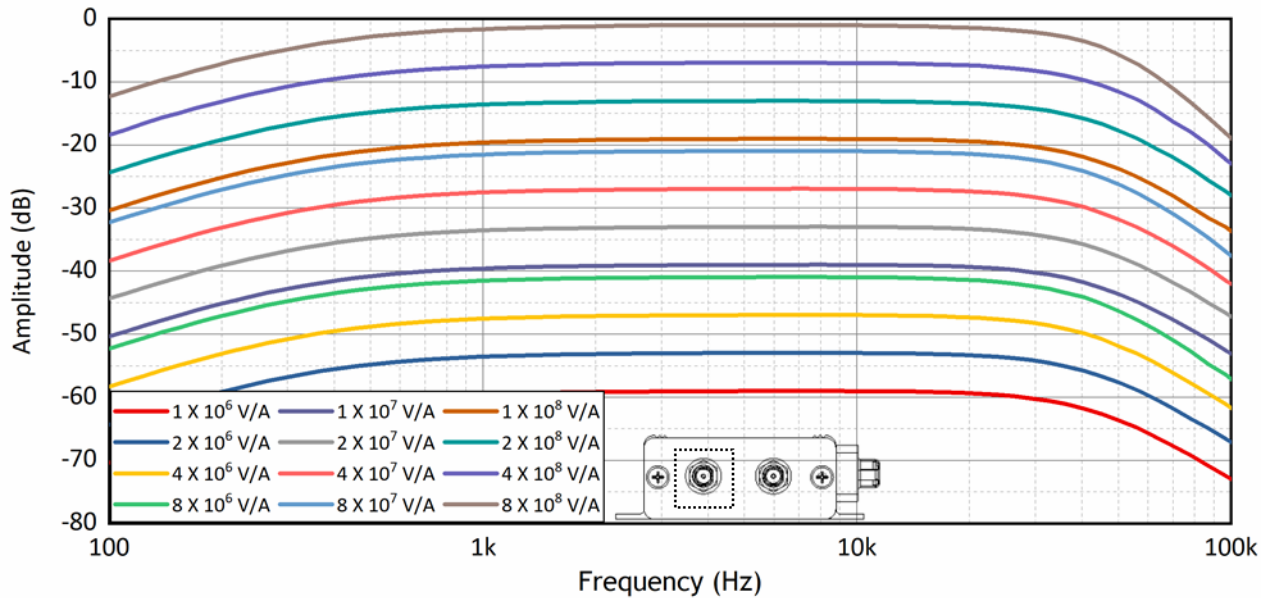
The below graph shows the AC characteristics of input 2:

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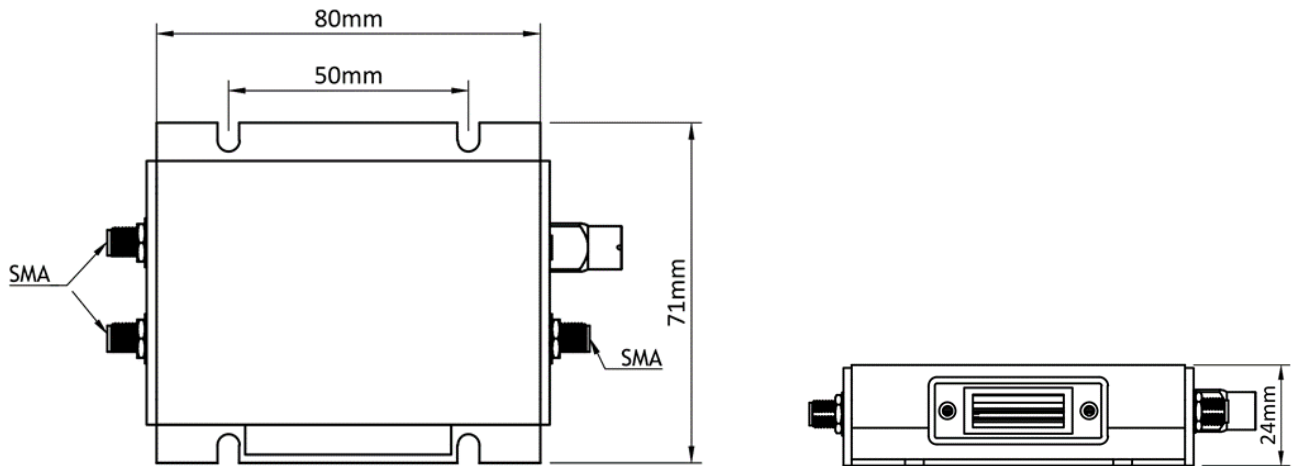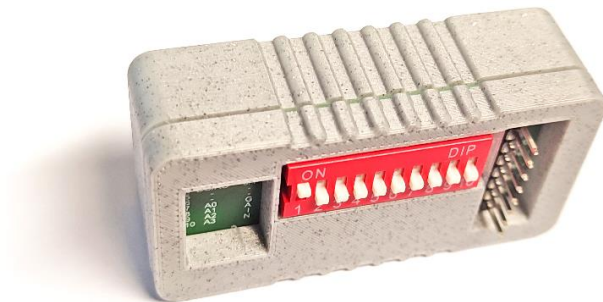
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Dimensions

Accessory

Manual Control Plug (MCP)

EU Konformitätserklärung
EU Declaration of Conformity

1. Gerätetyp/Produkt
   Apparatus model/Product   TeraSpike Companion

2. Name und Anschrift des Herstellers   Protemics GmbH
   Name and address of the manufacturer   Otto-Blumentahl Strasse 25
                                               52074 Aachen

3. Die alleinige Verantwortung für die Ausstellung dieser Konformitätserklärung trägt der
   Hersteller. *This declaration of conformity is issued under the sole responsibility of the
   manufacturer.*

4. Gegenstand der Erklärung   TeraSpike Companion
   Object of the declaration

5. Der oben beschriebene Gegenstand der Erklärung erfüllt die einschlägigen
   Harmonisierungsrechtsvorschriften der Union.
   *The object of the declaration described above is in conformity with the relevant Union
   harmonisation legislation.*

   RICHTLINIE 2014/30/EU DES EUROPÄISCHEN PARLAMENTS UND DES RATES vom 26.
   Februar 2014 zur Harmonisierung der Rechtsvorschriften der Mitgliedstaaten über die
   elektromagnetische Verträglichkeit

   DIRECTIVE 2014/30/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 26
   February 2014 on the harmonisation of the laws of the Member States relating to
   electromagnetic compatibility

6. Angabe der einschlägigen harmonisierten Normen, die zugrunde gelegt wurden, einschließlich
   des Datums der Norm, oder Angabe anderer technischer Spezifikationen, für die die
   Konformität erklärt wird, einschließlich des Datums der Spezifikation:
   *References to the relevant harmonised standards used, including the date of the standard, or
   references to the other technical specifications, including the date of the specification, in
   relation to which conformity is declared:*

   DIN EN 55032:2016-02; VDE 0878-32:2016-02 Elektromagnetische Verträglichkeit von
   Multimediageräten und -einrichtungen - Anforderungen an die Störaussendung (CISPR
   32:2015); Deutsche Fassung EN 55032:2015

   DIN EN 55035:2018-04;VDE 0878-35:2018-04 Elektromagnetische Verträglichkeit von
   Multimediageräten - Anforderungen zur Störfestigkeit (CISPR 35:2016, modifiziert); Deutsche
   Fassung EN 55035:2017

7. Nicht zutreffend.
   No applicable.

8. Zusatzangaben   --
   Additional information

Unterzeichnet für und im Namen von: Protemics GmbH
Signed for and on behalf of: Otto-Blumentahl Strasse 25
                                               52074 Aachen

Ort und Datum der Ausstellung: Aachen, 11.7.2022
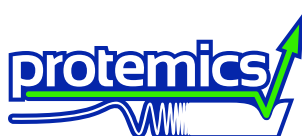*Place and date of issue*

Name und Funktion   Dr. Nagel, CEO
name, function

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https://www.protemics.com/

Important Notice and Disclaimers